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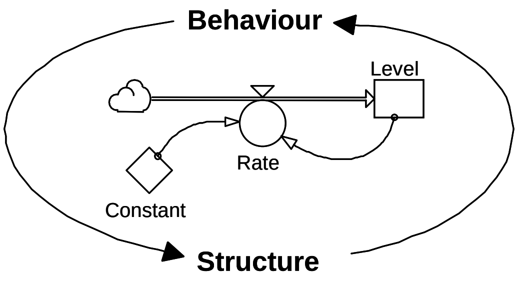

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By Matteo Pedercini

About the Author

Mr. Matteo Pedercini holds a Master's degree in System Dynamics from the University of Bergen, Norway, and a graduate degree in Economics and Business Administration from the LIUC University of Castellanza in Milano, Italy. He has contributed to the development of several national modeling applications and has published a number of papers including the following: "Models for National Planning," presented at the System Dynamics Conference 2003 in New York; "The Impact of the HIV/AIDS Epidemic on the Population Age Structure of Zimbabwe," presented at the System Dynamics Conference 2002; and "Evaluation of Alternative Development Strategies for Papua, Indonesia," a Master's thesis.

About the Center for Conservation and Government

The mission of the Center for Conservation and Government at Conservation International is to catalyze effective public sector responses to the crisis of biodiversity loss by engaging governments and related public institutions in seeking conservation solutions.

About Conservation International

CI believes that the Earth's natural heritage must be maintained if future generations are to thrive spiritually, culturally, and economically. Our mission is to conserve the Earth's living heritage, our global biodiversity, and to demonstrate that human societies are able to live harmoniously with nature.

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Foreword

In recent years, several large developing countries including Brazil, China, and Indonesia have launched programs to open up their resource-rich but poverty-stricken frontier areas. Those programs have often been led by public investments in large-scale roads and dams. Cost-benefit analysis and cost-effective analysis are the standard approaches for assessing the economic feasibility of such programs. In the past 10 years or so, some institutions have incorporated environmental and social impact assessment into their standard approaches.

It is rare, however, that development programs are compared across locations and sectors for their relative effectiveness. It is not clear, for example, whether investing $10 billion in highways connecting dispersed villages in the jungles of Indonesia's Papua Province is more effective for development than investing the same amount in infrastructure and job creation in the province's existing population centers. How important are such comparisons? How should the comparisons be conducted? What can we learn from existing work to help develop a new methodology that enables such comparison?

In response to these questions Conservation International (CI) began a "Comparative Assessment of Development Options" (CADO) initiative in 2002. The initiative is based on a concept of comparative analysis engineered by Jim Cannon, Deputy Director of CI's Center for Conservation and Government. Thus far, the CADO initiative has developed and tested a methodology for comparing the effectiveness of large-scale development programs across geographical areas and socioeconomic sectors. The goal is to enable policymakers to identify effective development programs that will minimize the need for altering natural areas, which support important biodiversity and ecosystem services.

A first step in the CADO initiative was to conduct an assessment of the contributions that existing computer-based models could make to developing the new CADO methodology. For this assessment we engaged Matteo Pedercini, a specialist in System Dynamics modeling. The result of Perdercini's work is the present paper, a comparative review of nine models currently used to support decision making about development programs. The review highlights the Threshold 21 model developed by the Millennium Institute (MI) as the model with the most potential to support CADO. Pedercini concluded that the "Threshold 21 program ... is the only model reviewed that fully ensures the possibility of cross-space, cross-sector analysis, and supports the comprehensive evaluation of all the aspects of the impact of a potential policy in the social, economic, and environmental systems of a region." Drawing on his conclusion, CI engaged the MI so it could apply the Threshold 21 model to several major development scenarios in the Papua Province of Indonesia. The Papua case study was completed in 2003, and the summary of that study is published separately.
We hope that this review will be of interest not only to modeling specialists, but also to policy staff members in development and conservation organizations who are searching for innovative tools that will facilitate socially, economically, and environmentally integrated planning and assessment of development programs.

Fulai Sheng Sr. Director, International Policy Initiatives Center for Conservation and Government Conservation International

Introduction

In many developing countries, development programs consist primarily of large-scale public investments in infrastructure, such as roads and dams. In most cases, a standard cost-benefit analysis is used to assess the suitability of such investments; however, effects on the local society and environment are not taken into account. Only recently, computer models have been used to perform integrated analysis of socioeconomic-environmental systems. Some of these models have the potential to support comprehensive policy analysis and comparison of cross-space, cross-sector investments. However, still missing is a standard methodology to evaluate the development effectiveness of large-scale public investment programs across geographical areas and economic sectors. The objective of the present work is to provide a solid basis for discussion of existing models and their potential to support the Comparative Assessment of Development Options (CADO) methodology.

A Brief Introduction to CADO

CADO is an approach to compare development programs according to their respective contributions to poverty reduction, economic goals, and environmental sustainability. The goal is to enable stakeholders to choose development programs in the locations and sectors that, in relative terms, meet their development goals more efficiently and effectively, with minimal impact on the environment and biodiversity.

Three essential steps are involved in implementing the CADO approach. The first is to determine—through a participatory and highly representative process—a set of criteria against which alternative development programs are to be compared. The second is to identify a few major alternatives to the policy or investment initiatives in question. The third is to assess the potential performance of the chosen alternatives against the chosen criteria. Tools for assessing the performance ex ante range from computer-based models to less-sophisticated decision making mechanisms based on expert opinions. One can also compare the achievements of past development programs across sectors and regions, identify the role of location and sectoral choices in determining performance, and target future investments toward those sectors and regions that have responded best.

For example, as a first step, a national government conducting a highly participatory Poverty and Social Impact Assessment, might determine that its main criteria to evaluate development alternatives are per capita income, primary education, and access to clean water and sanitation. As a second step, the government would identify a few investment alternatives, differing in their physical location and targeted sectors. Alternatives might include the business-as-usual scenario, a large trans-national highway project, construction of water treatment facilities to service major population centers, and a substantial investment in urban development and schools. The third step would involve using available expert information and computer models to evaluate the alternatives based on the criteria chosen in the first step. This information could be used to help inform decisions about future development policies and programs.

The purpose of the present analysis is to evaluate the potential of existing computer models, currently in use by development institutions for decision making support, to contribute to the third step of CADO.

On the Classification of Models for Decision making Support: Correlated vs. Causal-Descriptive Models

A large number of models are available to support decision making, and they can be classified in many ways, depending on the criteria used and the points of view of the classifier. We can distinguish between mental and formal models, between those that optimize and those that simulate. They can be static or dynamic, stochastic or deterministic, mathematical or physical, and so forth. Probably the most useful distinction that can be made to better understand the characteristics and the potential weakness of the models presented herein is the one between correlational and causal-descriptive models.

On the first side, correlational models are purely data driven and have no claim of causality in their structure. This definition implies that what really matters in such models is their aggregate behavior, which is independent of the particular characteristics of the internal structure that generates them. Econometric models, widely diffused in the field of macroeconomic modeling, belong to this category. Their main purpose is to produce short-or medium-term forecasts, and their validity depends principally on the adherence of the behavior generated by the model to historical data series. The modelers' efforts are concentrated on improving the models' ability to reproduce the past behavior of real systems, and not on representing the real system's structure. Because the focus is on input-output behavior and scarce interest is given to the internal structure of the model, these types of models are not designed to be transparent and are often labeled as "black boxes."

On the other side, causal-descriptive models are theory based: their structures represent a theory about how the real system actually operates. What really matters in such models, therefore, is the validity of their structures: their capacity to correctly represent the mechanics that generate the observed phenomenon in the real world. System Dynamics models, as all structure-oriented models, belong in this category. Their main purpose is policy testing. To function, they not only have to reproduce the historic behavior of the real system, but also have to explain the structural determinants of such behavior. Modeling efforts are, therefore, concentrated on replicating—with an adequate degree of detail—the system of interest. This type of model can be designed to allow the user to investigate and manipulate its internal structure and study the relationship between the structure and the behavior of the model. Such models are often labeled as "white-boxes" to emphasize their transparency.

Correlational and causal-descriptive modeling techniques present different weaknesses. The main problem with correletional models is that the strength of the relationships between different variables is estimated on the basis of statistical regression routines. Those statistical techniques do not prove the causality of the relationship but only refer to the level of past correlation between two or more variables observed in the system. However, we know that there is no guarantee that the same relationship we observed in the past will hold true in the future. This shortcoming can seriously undermine the ability of the model to produce relevant forecasts, which is generally its main purpose.

Another problem affecting correlational models is that, because of the characteristics of the techniques used to estimate the equations' parameter values, the models must focus narrowly on hard data. This focus clearly excludes all possibilities of incorporating in the model any important relationship for which accurate data series are not available and, therefore, strongly limits the range of applicability of this type of model.

Causal-descriptive models also face numerous potential problems. When developing a causal-descriptive model, the first challenge the modeler faces is to define the model's correct boundaries. As reported in many cases, boundaries that are too narrow can cause the omission of important feedbacks, with extremely serious consequences in terms of the model's validity. Yet, boundaries that are too wide can lead to the creation of enormous models that are difficult to manage and are scarcely useful. The common solution to overcome this difficulty is to focus the modeling activity on a specific problem and not generically on a system. The focus then is to consider as endogenous only those variables that are crucial to explain the problematic behavior of interest. The tendency to focus on a specific problem, however, can generate a second problem: narrowly focusing on known problems can lead to models that neglect potential hidden dynamics, thus reducing the usefulness of the model for policy testing.

A final important problem affecting causal-descriptive modeling is related to the difficulty of representing in a simulation model the decision making rules observed in the real system. Human decisional rules can be extremely complex and difficult to capture, and the soft variables on which they are based are difficult to estimate. Moreover, if the model's behavior is very sensitive to those decisions, wrong formulations or estimates can lead to inaccurate conclusions.

In spite of the severe limitations that can affect the two methodologies, however, both can be useful to some extent, depending on the specific needs of the user. Because they are more transparent and more suitable for policy testing, causal descriptive models tend to make the most useful contributions to CADO, the type of methodology that this paper intends to promote.

In reality, most decision making models include both causal-descriptive and correlational elements. The models presented in this work are principally causal-descriptive and use different methodologies to represent the structure of the systems. As described in the following pages, the various methodologies used to construct models influence their transparency and comprehensiveness and ultimately determine the usefulness of these tools for CADO.

Methods

This report is a comparative review of nine major models currently used to assess the effectiveness of public development investments. The models are evaluated based on twelve fundamental criteria.

The list of models reviewed in this paper does not claim to be complete nor exhaustive. The number of standardized models that can potentially be used to assess the effectiveness of public investments is very high, even without counting the many models that are created ad hoc to analyze specific cases. The models reviewed here are, therefore, only a small subset of the models in the field and have been chosen based on their wide acceptance and their visibility in the development community. Far from being fully representative of all the models used to analyze development investments, this sample offers a panoramic review of the most widely used methodologies in the field. (The analysis was concluded in June 2002, and it is based on the most recent versions of the models available at that time.)

The research was conducted by examining the models' guides and documentation, as well as by running and testing the models on an ordinary desktop computer. (This research was not possible in one case, because the model was not made available by the software developer.) While the fundamental relationships that form the structure of the model should be correctly described in this analysis, certain aspects may be misunderstood. In general, the misunderstanding of the functioning of a model is a good indirect indication of a low level of transparency. Any corrections are welcome from model developers and experts in the field.

The quality and validity of a model can only be assessed in reference to its ability to provide insights into a specific issue. The author's views of the models analyzed in this paper refer to the ability of such models to support CADO, and should not be taken as absolute judgments of those tools. The author worked with CI staff members to identify 12 major characteristics that a model should possess to be fully useful for CADO. This paper presents an evaluation of each of the models based on these criteria. The following section describes the assessment criteria used.

Assessment Criteria

Transparency

Transparency indicates the degree of clarity and explicitness of the model's structure and assumptions, which are fundamentally important to allowing civil society and the private sector to participate effectively in the analysis.

Comprehensiveness

Comprehensiveness refers to the model's ability to represent the socioeconomic-environmental system of a region as a whole, by integrating in a single framework all the relevant aspects of development planning.

Policymaking Guidance

Policymaking guidance refers to the model's usefulness for guiding policymaking, that is, the extent to which it provides relevant cross-sector policy insights to support long-term development planning.

Strategy Comparison

This criterion measures the usefulness of the model for prioritization: the extent to which it allows for an easy comparison of alternative development strategies and supports the assessment of the feasibility of implementing strategies, both fiscally and institutionally.

Long-Term Perspective

Long-term perspective indicates the extent to which the model enables both short-term analyses (1 to 3 years) and long-term perspectives (up to 30 years) for national policymaking.

User-Friendliness

User-friendliness refers mainly to the ability of the model's interface to give operators rapid access to the main functions while using simple commands, to clearly display the output, and to help orient operators so they can find the information they need.

Environmental Analysis

This criterion indicates the extent to which the model can calculate various environmental indicators for all scenarios and its usefulness for performing environmental impact assessments.

Poverty Analysis

This criterion refers to the model's ability to calculate income distributions for all scenarios and to identify how the potential benefit deriving from a particular policy is shared between the different income classes.

Partnership Building

Partnership building indicates the extent to which the model is able to produce structured outputs in standard formats that can help coordinate the participation of development partners.

National Development Indicators

This criterion simply refers to the model's ability to calculate and display national development indicators for each scenario projected.

Continuous Time-Series Output

This criterion determines the model's ability to produce the continuous time-series outputs for major variables, which are essential for effectively monitoring and evaluating development programs.

Applications

This criterion is used to report the extent of diffusion of the model, as well as the cost, the time, and the effort required per application.

PoleStar

The Stockholm Environmental Institute (SEI) launched the PoleStar project in 1991 to advance the methods, concepts, data, and institutional capacity for sustainable development analysis. PoleStar is an adaptable accounting and model-building framework, the main structure of which can be viewed as a complex of interacting spreadsheets. The model is modular, and its base structure can be modified or extended to adapt it to a specific country situation. The Polestar system does not reflect any specific existing approach to environmental and developmental studies; it should be seen as a flexible tool that was created to support analysts who are from different approaches and are engaged in sustainability studies. The model's main modules and their links are shown in Figure 1.

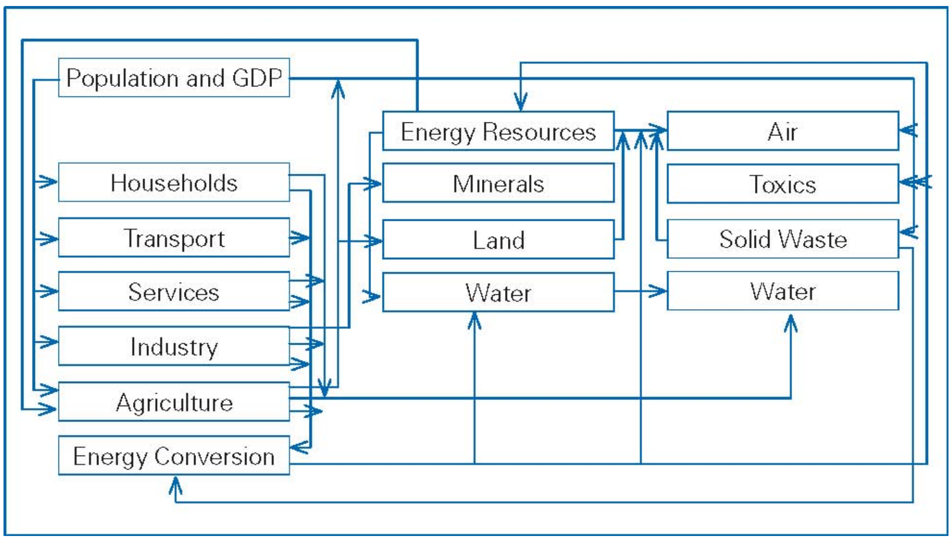
Transparency

The model is perfectly transparent, and the user can easily have access to all of the model's equations. Most of them can be freely edited but a few of the core equations are read-only. The model's main assumptions are also immediately clear. Many of the complex equations used in the different modules are explained in detail in the documentation and are easy to understand.

Comprehensiveness

PoleStar is articulated on 15 modules that would be expected to cover the main economic, social, and environmental aspects of a region, a nation, or even the whole planet. In reality, the proposed structures are far from being comprehensive, and the causal relationships between the different modules are not extensively developed.

Figure 1: PoleStar Module Linkages in the Basic Structure



SOURCE: Raskin et al. (1996).

For example, the population and the gross domestic product (GDP) in the model are given as exogenous. Users are, therefore, expected to complete the structure if they want to represent the main aspects of the region as a complex of organic and interacting parts.

Policymaking Guidance

The system has huge limitations regarding the possibilities of establishing links between the different modules and variables. In particular, it is not possible for the user to create feedback loops, which are the main mechanisms that, in reality, drive and limit the growth of populations, economies, resource consumption, and so forth. This limitation affects the model's ability to represent the real-world system and consequently its usefulness as a policymaking support tool.

Strategy Comparison

The PoleStar user can easily set different scenarios for the future and can modify them to reflect the implementation of different policies. The user can then compare the effects of the different policies on the development of the region to identify which policy has the greatest positive effect in driving the country toward sustainable development. However, because the model has limited ability to consider links between the different sectors, it can provide only poor insights on the real effect of a policy on the whole system. In the model, for instance, the introduction of a fuel tax (e.g., to reduce truck traffic on the roads) would not affect the GDP growth.

Long-Term Perspective

The model's time horizons can be customized using simple operations. Users can run the model to represent only one year or a century, although, given the structure of the model, the results for the long-term would tend to be unrealistic. For example, the population modeled using the basic structure would continue to grow exponentially for the whole simulation if no exogenous factors were set to limit it. After the simulation of 100 years, we would have an enormous population, independent of economic and environmental changes during the century.

User-Friendliness

Users without any specific computer skills or knowledge of modeling techniques can quickly learn to use the PoleStar system. The reference structure is particularly simple, and users will find it easy to find the desired data. Data can be displayed as customizable graphs in the model or can be exported to other applications (for example, Microsoft Excel), if the user needs to present the results of the analysis in different ways.
Entering the initial data and building scenarios are not difficult tasks, so if there is no need to extend the basic structure, the user can initialize the PoleStar system without the support of a modeler. In any case, the user should carefully evaluate the adequacy of the basic structure with respect to the objectives of the analysis he or she intends to perform. For this, the presence of an experienced modeler is advisable.

Professional assistance is also necessary if the user believes the basic structure does not satisfactorily represent the aspects of the system being analyzed. Even though the programming language is very simple, good modeling skills are required to maintain coherence in the model while modifying its equations.

Although at a highly aggregated level the interaction of the model's main sectors can be easily identified, it is very difficult to have a clear, detailed picture of how the different variables are linked. In fact, links between variables are not graphically visible and are not always intuitive so one cannot realize the networks of relationships constituting the model simply by looking at the equations.

Environmental Analysis

The model provides a wide range of indicators to monitor natural resources consumption and pollution. It allows the user to keep track of the reserves of energy, water, and minerals and of land use. The model distinguishes between pollution in the air, in the water, and in solid waste. It also takes into consideration separately the amounts of different toxic waste in the region. Finally, the model can calculate the amounts of energy and natural resources consumed by the different sectors, thereby allowing the user to monitor the major causes of pollution and the more environmentally friendly activities.

Poverty Analysis

The model can calculate the income distribution of the population using the Gini coefficients set at the beginning of the simulation. It calculates the highest and lowest quintiles. The user can set the poverty line (a level of annual income below which people are living in poverty), and the model will calculate both the percentage of the population living in poverty and their absolute number.

Partnership Building

The model's flexibility allows users to build all the indicators needed by the potential institutional partners if those indicators were not present in the basic structure. In many cases, this approach may imply not only the elaboration of existing data, but also an extension of the basic model's structures. Good modeling skills are required to do this step.

National Development Indicators

The model has been clearly designed to consider mainly the problems of nonrenewable resources consumption and pollution. The model permits the user to monitor those aspects of development; however, for assessments concerning population dynamics and economic development, the basic structure of the model is quite poor. The model, in fact, provides only a framework within which the user must build all the economic and population sectors of the country. It will eventually create the indicators to be used for monitoring.

Continuous Time-Series Output

The model is able to produce data for the major variables only in specific moments in the simulation as specified by the user. The values displayed on the graphs for the rest of the simulation are linear interpolations of the calculated points. Although the user can freely add many "scenario years" (a kind of check point) during the simulation to keep better track of the development of the main variables, this process is not very intuitive and is time-consuming. Moreover, the user may not know—before looking at the simulation's results—when (and where) the turning points in the country's development will be. The user can find those points only by adding more and more scenario years until satisfied with the approximation obtained. Not only is this method inefficient, but it can also easily lead the user to miss some hidden crucial point in the hypothetical future of the country.

Applications

The PoleStar system is widely used, and the time and effort required to customize the model to fit a specific nation's situation are limited. These qualities reduce the costs of implementing the model to the cost of the software (US$1,000) and the optional 3 to 5 days' training offered by SEI.

Final Comment

First, the PoleStar system appears to be a very transparent software that can be rapidly and easily implemented in many contexts, thanks to the flexibility of its basic structure.

If the user does not need to extend the model, the cost of its application for a specific country's region—both in terms of time and energy—is contained.

In reality, however, the basic structure of the PoleStar model is clearly oriented to the study of natural resources consumption and environmental pollution, while the socioeconomic sector is insufficiently developed for any users who are interested in analyzing how a region's environment, society, and economy interact. In that case, the user must engage a skilled modeler to expand the boundaries of the model and to incorporate the many important missing relationships between the major variables, which is a huge effort. Therefore, the model's ability to consider cross-sector investment issues depends on the quality of the extension work done by the modeler.

A second shortcoming of the model is that it is ill-suited to represent feedback loops between variables. Thus, the software cannot represent the primary mechanisms that in the real world both drive and limit the growth of socioeconomic systems.

Finally, although PoleStar has a user-friendly interface and data report, it has limited usefulness for comparing cross-sector investment alternatives on a long-term horizon.

RMSM-X

The Revised Minimum Standard Model Extended (RMSM-X) was developed by the Development Economics Vice Presidency of the World Bank and can be considered as the logical evolution of the RMSM, which has been applied for more than 20 years in many countries.

The RMSM-X is a Microsoft Excel–based model that was built to support country economists in policy analysis. The model focuses in particular on the representation of the demand side of the economy by using an economywide and consistent flow-of-funds accounting methodology and a recursive approach. The RMSM-X, while preserving many of the key characteristics of its precursor, introduces multiple economic agents to support the analysis of a wider spectrum of policy options. Moreover, the model can be solved with different closure procedures, depending on the focus of the analysis. Its structure, composed of four main interacting modules, is shown in Figure 2.

Transparency

Both the equations in the model and the macros are accessible for reading and editing, thus ensuring a high degree of transparency of the software. Although the Excel language for writing equations is straightforward, the macros' programming language is not as easy, and it can take a long time for an inexperienced user to fully understand the way the software works.

Comprehensiveness

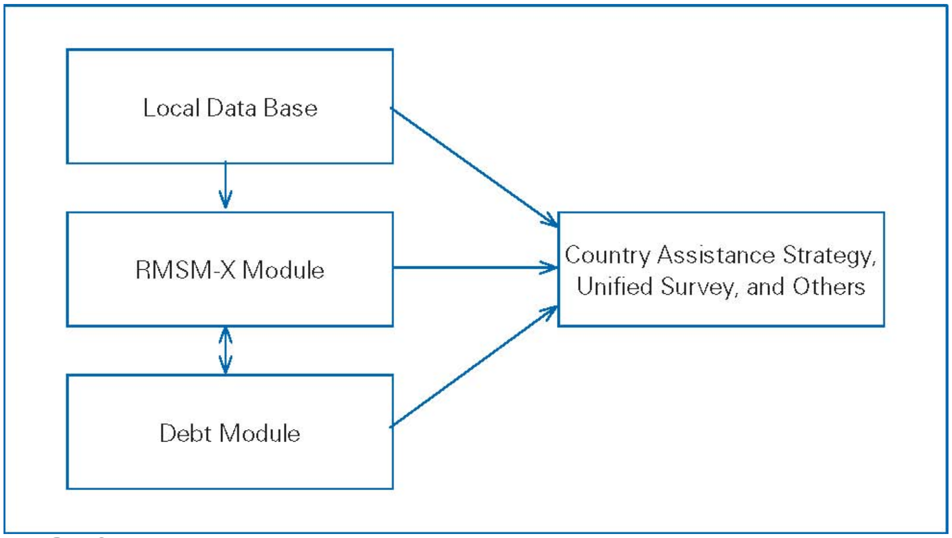
The model has been designed to represent one country's economy and does not consider the social and environmental aspects related to the country's development.

Although the user can customize the model by extending its structure and by adding new modules or agents, the work required to represent social and environmental dynamics in the RMSM-X can be compared to the effort needed to build a completely new model.

Policymaking Guidance

The high degree of aggregation that characterizes the way the RMSM-X represents a national economy does not allow a detailed analysis of specific economic sectors. It is not possible, therefore, for the user to specify detailed policies for one specific sector or area and then to observe the effects of those policies on other sectors. What one can learn in terms of policy analysis from this model depends on the different type of closure chosen. For example, the model can calculate the values of private consumption, and the domestic borrowing or domestic purchase of government bonds that will be consistent with the projected paths of output growth, with inflation, and, particularly, with fiscal variables. The capability of the model to give cross-sector policy insights is therefore strongly limited.

Figure 2: RMSM-X Main Modules and Links



SOURCE: Development Data Group (1997).

Strategy Comparison

Alternative development strategies can be developed and tested with the model. According to the chosen solution procedure, the user can specify target values (or expected values) for some of the key variables and can observe the corresponding simulated behavior of the others. The user can then compare the different strategies and immediately assess their fiscal and institutional feasibility. However, the user will be able to define strategies only at the level of the major macroeconomic variables of a country without going into the detail of their application. In theory, the model could be extended to incorporate more detailed structures, but practically customization would be a profoundly time- and energy-consuming modeling activity.

Long-Term Perspective

The RMSM-X has been created to produce short- to medium-term projections of the main macroeconomic variables for a specified country. The way the GDP and the population growth are modeled leaves no doubt that long-term projections generated by the RMSM-X would be of little significance. The user is expected to set the growth rates for both population and GDP in the private and public closures; in the policy closure, the GDP growth is calculated on the basis of the gross domestic investment and the Incremental Capital Output Ratio. To consider those variables as exogenous (as is true of many others) implies a limit to the time horizon over which any projection can give relevant insights.

User-Friendliness

Those users who have had previous experience with Microsoft Excel will find the software environment particularly familiar. Each module of the model, in fact, is structured on many different interacting Excel sheets, which are organized according to the data they use and generate. By clicking on any of the cells in each sheet, the user can inspect the formula it contains, change it, or introduce data wherever necessary. The user can also use Excel tools to build customized graphs to monitor particular variables. All the operations are very intuitive, and even users who are not familiar with the application can quickly learn how to manage them. The color scheme used to identify the role of each cell in the different closures is also very useful. Moreover, a set of customized command buttons has been created to make it easier to choose between the different solution procedures, to create graphs, to save scenarios, or to import and export data.

The main limitation of the software in terms of user-friendliness is related to the language and to the aggregated level of the equations. Users who are not economists may find it difficult to understand what many of the indicators mean, and especially what assumptions underlie the equations that are the model's foundation. The user's guide and the reference guide are extremely helpful in this sense, but users who are not economists will have a comprehensive understanding of the way the model works only after they work with the application a long time. Besides, there is no graphical representation of the causal relationships that link the different variables in the model. It can be very difficult to reconstruct the network of connections that constitute the main structure of the model if the user looks only at the equations.

Environmental Analysis

The RMSM-X does not describe the environmental system of a country nor does it consider the environmental effects of policies implemented in the economic sector. Therefore, the model performs feasibility assessments of a particular development strategy only from a strictly economic point of view and cannot address long-term sustainability issues.

Poverty Analysis

Although the RMSM-X is not able to calculate the income distribution for different scenarios, it would be possible to extend the model's basic structure to consider such aspects. However, this very demanding task would require the support of a skilled modeler.

Partnership Building

Even the basic version of the RMSM-X generates all the projections required for the World Bank's Standard Tables, Country Assistance Strategy/Country Strategy Paper Annexes, and Unified Survey. Moreover, the Output Generator module can be easily customized to calculate additional indicators, if required. The flexibility of the software, in fact, allows the user to pick up data from any of the many interactive sheets, to build the desired economic monitoring variables, and then to display them using the many tools available in Microsoft Excel.

National Development Indicators

As discussed in the preceding paragraph, the model is versatile in terms of generating economic indicators. Unfortunately, no indicators related to other aspects of a country's development are available in the model. In particular, the way the population is modeled does not allow the user to derive any relevant social indicators without intensive customizing to complete the original structure. The picture of a country's development trends that the user can derive from the basic model is, therefore, limited to a short-term economic analysis.

Continuous Time-Series Output

The RMSM-X can generate discrete yearly output series for all of the indicators defined. Also, modelers can create customized monitoring and evaluating modules to satisfy users' specific needs. The time horizon over which the model calculates output values can also be easily extended. Because of the features of the model's structure, however, the time series produced are significant only for a short- to medium-term policy analysis.

Applications

The RMSM-X can be considered as the natural successor of the RMSM, a macroeconomic model that has been applied over the past 20 years in many different countries. The RMSM-X is similarly widely applied, also because of the simplicity of its implementation and because it is freely available. No additional costs for training in using the application should be considered for those who have an economic background. The data required to initialize the model are normally easily accessible. If such data are consistent, the initialization process should not be particularly time-consuming.

Final Comment

The RMSM-X introduces many important features and tools for macroeconomic modeling. One is the overall flow-of-funds matrix, which guarantees the consistency of the model with respect to basic accounting principles. This feature and many other characteristics of the RMSM-X make it a basic tool for short-term feasibility analysis of financial policies and an important reference when developing macroeconomic models. Thanks to the popularity of the software used to create RMSM-X, the model is particularly transparent. Most users will feel at ease—even the first time—when introduced to the familiar Excel environment. Customizing the RMSM-X to represent the economic system of a specific country is also very simple. The required data are easy to find, thus limiting the time and resources needed to completely implement the process. The simplicity of the model's structure and environment contrasts with the technical economics language used, which makes the software fully understandable only for users with good macroeconomics background.

The model's main limitation as a policymaking guidance tool derives from both its short-term orientation and its narrow focus on national economic systems. The model offers no possibilities to test policies on a long time horizon, and the model's structure does not represent environmental and social systems. These limitations strongly reduce the possibility of gaining relevant insights on the long-term sustainability of different policies.

PDE

The Population-Development-Environment (PDE) model was developed by the International Institute for Applied System Analysis and was implemented during 1997–2000 in Botswana, Mozambique, and Namibia. The PDE represents the complex socioeconomic-environmental system of a country as an integrated dynamic model and provides an intuitive and efficient tool for decision makers, stakeholders, and scientists. The methodology on which the model is based, System Dynamics, focuses on the relationships between the structure and the behavior of the systems while emphasizing the role of feedback loops, accumulations, and delays in generating specific behavioral patterns. The PDE model is organized in three concentric circles or rings, with the population in the center circle, surrounded by the developed environment ring, and then both embedded in the natural environment ring, as shown in Figure 3. Each sector represents a different submodel (or module), the output of which derives from and influences the outputs of the other modules.

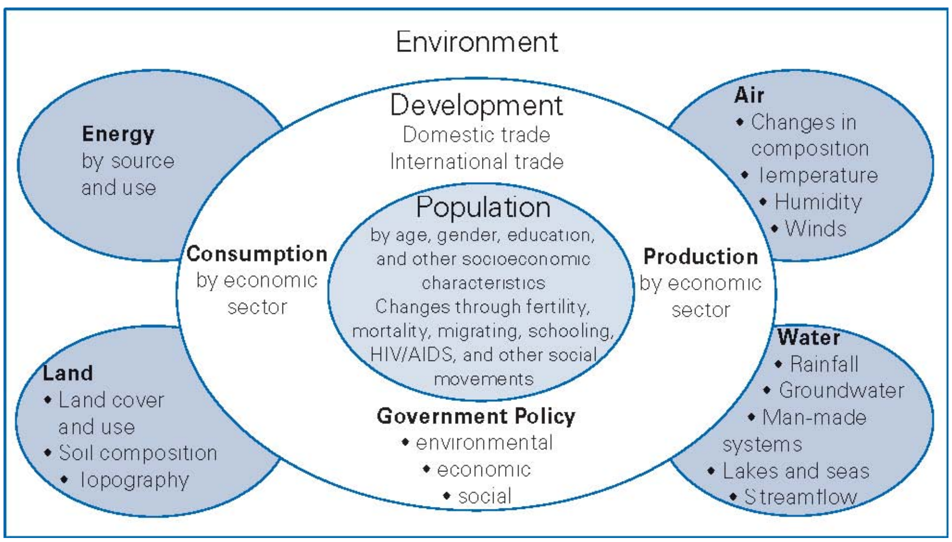
Transparency

The PDE model is perfectly transparent, and the user can easily have access to the formulations for all the variables and can observe how they are linked to each other. The user can immediately identify what inputs are used to calculate each equation and how the output generated affects the value of other variables. Moreover, the main assumptions of the different modules are clearly indicated, and the user can check and modify them to create new and different scenarios.

Comprehensiveness

The fundamental assumption of the model is that population and environment are not separate entities that can be seen independently or even in opposition to

Figure 3: PDE Structure Overview



SOURCE: IIASA (2001).

each other. The structure of the PDE, therefore, represents population, which is the main point of interest, as an integral part of nature. This high degree of comprehensiveness has been reached by organizing nature on three concentric levels: population, manmade or developed environment, and natural environment. All human life is embedded in and is affected by the surrounding environment. Nature is organized into four categories: air, water, land, and energy. This kind of structure guarantees the possibility to analyze all the main social, economic, and environmental aspects of development planning.

Policymaking Guidance

Of the three sectors composing the PDE, only population can be considered a standard module suitable for most applications. The other two sectors, in fact, must be created specifically for each new application, to focus better on the most important aspects and issues related to different economic and environmental systems. Therefore, the extent to which the PDE is able to give relevant cross-sector policy insights strongly depends on the quality of the extension work done to customize the model for a specific country's situation. Although in the past, applications of the model in Botswana, Mozambique, and Namibia were conducted accurately, this required significant time and economic resources.

Strategy Comparison

The structure of the PDE model allows the user to analyze the effect of various policies directly on the population's development, or via the effects on the economic and the environmental systems. As pointed out previously, the development and environment modules must be created appropriately for each new implementation of the PDE. The capability of the model to support cross-sector and cross-space strategy comparison strongly depends on the validity of customization work.

Long-Term Perspective

The PDE model can explore a set of alternative development scenarios up to years 2020 or 2050, and the data are normally reported on a monthly basis. Such features, together with the characteristics of the methodology on which the model is based, make the PDE particularly suitable to give relevant insights into the country's development, both in the short and the long term. Naturally, the projections generated by the model should not be taken as forecasts, but as foresights on specific what-if scenarios. The aim of the model is not to make point predictions about future behavior of the system; the model should be used for pattern predictions and to guide national policymaking.

User-Friendliness

The methodology that is the basis of the PDE, System Dynamics, makes the model extremely useful for learning and understanding the relationship between the structure of the system and its behavior. The model is built in Vensim, a simulation environment from Ventana Systems. Users who are not accustomed to this software would need some tutorial sessions to fully understand the way it works; but it's a price worth paying, considering the many excellent possibilities for system analysis offered by this brilliant application. After a few hours of training, in fact, most users will find it easy to create customized graphs for the different key variables, to analyze the relationships between those variables using the "Causes Tree" and the "Uses Tree," and to understand the origin of the model's behavior by looking at the "Loops" and by directly following the causal paths in the stock-and-flow structure. All the basic functions of the software are available simply by pressing on the icons on the main toolbar, which can also be customized to introduce more direct links that run different tasks.

Although the Vensim tutorial can be a helpful guide for new users, the support of an expert can speed up the learning process and quickly make the application's potential available to the client. As everyone facing new software knows, the users will initially have some trouble getting the feel of this new environment, but Vensim's particular features guarantee a high degree of user-friendliness after the first moments of acclimatization; the interface will allow users to efficiently and easily communicate with the application.

Environmental Analysis

The PDE model does not offer a standard environment module that can be applied in different countries. A module would have to be built specifically for each application so it could focus on the particular environmental problems a country is facing. In the three applications of the PDE in Botswana, Mozambique, and Namibia, the environment modules have been created to analyze the dynamics of water availability in their territories, concentrating only on a specific aspect of the effect of population and development on the environment, These three country applications show that there are few limitations to the possibilities of creating and monitoring key indicators.

Poverty Analysis

The PDE's demographic model has a structure that allows the user to keep track not only of the total number of individuals living in the country, but also of their relevant characteristics, such as age, gender, education level, and others. This detailed population description, combined with the outputs from the economic model and the Gini coefficients for the country, makes the analysis of income distributions easy to perform, and it ensures relevant insights.

Partnership Building

The flexibility of the PDE software enables the modeler to create the set of indicators needed by any eventual institutional partner. Naturally, the relevance of the values calculated for these variables strongly depends on the validity of the underlying structures created to represent the economy and the environment of a specific country.

National Development Indicators

For each scenario generated, the PDE model allows the user to follow the development of the country by monitoring the key indicators for population, development, and environment. Most of the relevant variables for national development can be endogenously calculated by the PDE, thus guaranteeing a high level of significance of information generated in terms of its policy guidance, even on a long-time horizon.

Continuous Time-Series Output

The PDE model is able to produce continuous time-series output for all the variables that compose it, thereby giving the user a chance to monitor in detail and to evaluate the state of the system in each moment of the simulation. In reality, the model calculates the system's state at discrete intervals. The solutions for intermediate points are graphically given as linear interpolation between the previous and the next calculated values. However, when the integration interval chosen is sufficiently small, this output can be considered to be a good approximation of the theoretical continuous one.

Applications

PDE models have been disseminated and implemented at institutions in Botswana, Mozambique, and Namibia.

The projects have been conducted with funding from the European Union, a necessary contribution given the huge amount of work required to adapt the model to a specific country's situation. The customization work required for the PDE, in fact, consists of more than just finding reliable data to feed the model or making small modifications to adapt it to represent particular issues. Rather, it consists of real modeling work to create the environment and development modules. That work should be carried out by a team of modelers and experts from the different sectors and would surely require a consistent supply of time and money.

Final Comment

The methodology underlying the PDE model, System Dynamics, gives the user major advantages in terms of transparency and potential insights on the relationships between the structure and the behavior of the actual system. That methodology, together with the Ventana Systems software, makes the PDE not only a useful tool for policymaking support but also a potentially rich learning environment. Moreover, the simple programming language of the software is a key aspect when involving the user in the modeling process, and it helps to build confidence in the model. In that sense, the PDE approach should certainly be considered as a crucial reference for supporting the CADO methodology.

In the difficult trade-off between standardization and specialization, the PDE model can be considered more as a tailor-made model than a general one. Only one of the three modules, population, can be considered standard and can be applied with only few modifications to a country's situation. As a result, the model will probably be able to represent the country's specific economic and environmental systems in more detail. However, this structure also produces two negative consequences. First, the cost and the time required to implement the model for a specific country are significant. Second, having two customized modules reduces the possibility of comparison between the results of different applications of the model.

Threshold 21

The Millennium Institute's Threshold 21 (T21) is a System Dynamics national model expressly designed for policymaking support. T21's design integrates economic, social, and environmental structures into one specialized tool. The model is organized in three macro sectors: the society, the environment, and the economy (which is based on a Social Accounting Matrix and on Cobb-Douglas production functions). The sectors interact with each other as shown in Figure 4. Each application of the model is built around a core model—a set of main structures representing features of the socioeconomic-environmental systems that can be generalized across many countries—to which additional modules can be added to better portray specific aspects of the country being analyzed.

Transparency

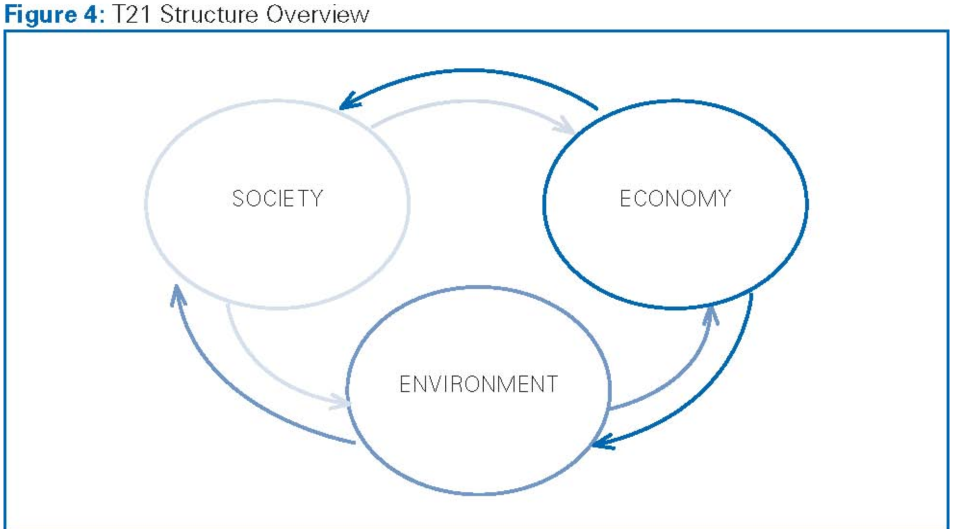
In the T21, nothing is hidden to the user's eyes. All variables constituting the structure of the model are accessible and generally well documented. All the relationships between variables are immediately evident, thanks to the stock-and-flow diagrams used to represent the structures of the different sectors. Moreover, all the assumptions underlying the different modules are clearly stated, with the aim of stimulating the users' confidence in the model as much as possible.

Comprehensiveness

Figure 4: T21 Structure Overview

The T21 was conceived explicitly to represent the socioeconomic-environmental system of a country as a whole. This goal has been achieved, thanks to a complex structure that considers that any kind of human activity influences and is interdependent with the environment. This understanding, in turn, affects the economy and society

Figure 4: T21 Structure Overview



SOURCE: *Qu and Barney y (2001.*

in general. To have rapid economic development, for instance, a country needs an efficient workforce, which will need clean air and water to be healthy and productive. Conversely, intensive economic activities can pollute the environment, compromising any chances of further development.

Policymaking Guidance

The T21 model can be seen as an organic whole of parts, in which every element influences and is influenced by the others, in a close network of feedback relationships. This kind of structure implies that every action taken locally in one sector will somehow influence the behavior of other sectors, perhaps with a certain delay. When testing a policy in the T21, therefore, the user will be able to observe both its direct effects on the target sector and its indirect effects on the rest of the system in the long run. Thanks to the Causal Tracing feature offered by the software, users can easily determine which components of a specific development plan have caused a particular change in one variable or indicator. The user can rapidly identify the leverage points of the system, a necessary condition for designing effective policies.

Strategy Comparison

Users of the T21 can test different policies in different sectors and can estimate the costs and benefits they generate, both locally and within the system as a whole. Alternative development plans can, therefore, be compared on the basis of their cost and of their contribution to moving the system in the desired direction. Given the economic, human, and environmental resources available, users can immediately assess the feasibility of implementing potential policies, both at the moment of intervention and in the long run.

Long-Term Perspective

The T21 allows users to choose to focus on short-, medium-, or long-term analysis by simply modifying the time horizon of the simulation. For long-term analysis, the simulation is generally run over 35 years, from 1990 to 2025. It will consider the past development of key variables that led to the current situation, as well as the potential effect of any policy on the future development of the country.

User-Friendliness

When the T21 is opened for the first time, users immediately feel at ease in the simple and well-structured environment. From a main menu, the user can go directly to the simulation and the definition of different scenarios or can pass through a tutorial introduction that describes the model's purpose and main characteristics. A separate tutorial chapter describes the model's structure, in which all sectors of the model are represented in detail by stock-and-flow diagrams.

The different windows of the model are organized hierarchically, and the navigation is made easy by simplified command buttons on every page. When approaching the operative part of the application, the user is guided—with clear indications about what variables the user can manage—through the process of creating a specific scenario. Users will find this process to be very intuitive, thanks to the accuracy and simplicity of the interface. All the user has to do when defining assumptions or policies is to set the values of the desired variables with slide bars or to draw them on plain time graphs.

After the simulation has been run, the results can be reported in different forms, depending on the user's needs. Generally, data relative to the national accounting system are presented in tables, and the behavior of most of the other indicators is reported on time graphs, which are very easy to read and compare. The population development is also described with dynamic pyramid graphs that report the number of people per age and gender. The Causal Tracing function allows the user to navigate the network of causal relationships between variables and to identify the effects of each policy on the system. The user also can compare the results of different simulation runs, thanks to a Scenario Comparison tool that is easy to use, as are most of the functions offered by the software.

Environmental Analysis

The core of the model's environmental macro sector describes the mechanisms of pollution accumulation, the consumption of nonrenewable resources, and the land use. Other sectors can be added to the core to better portray the country's specific situation, including modules for analyzing the dynamics of fossil fuels' consumption, air pollution, water pollution, and greenhouse gases. The resulting model's structure considers the effects of human activities on the environment and produces a wide range of indicators to help the user evaluate the environmental effects of different policies.

Poverty Analysis

T21 is a very useful tool for poverty analysis. Not only can the model calculate the real GDP per capita and the income distribution, but it can also produce the Human Development Index (HDI) and other overall indicators on poverty and employment levels. The income distribution and employment algorithms used in the T21 support a variable number of income classes (quartiles, quintiles, etc.), thus ensuring the possibility of increasing the accuracy of the analysis when necessary to meet users' needs. Given the comprehensiveness of the information generated by the model, the user will find it easy to identify how the outcomes of different policies will benefit the poor, and will, therefore, be able to design interventions for target income classes.

Partnership Building

The T21 automatically produces all the outputs required for the United Nations Development Assistance Framework table, including indicators for health, education, and poverty, for every year in the simulated future and for every scenario the user would like to define. The model also generates all the information needed to complete the Country Assistance Strategy (CAS) report for the World Bank, and many other indicators can be created or derived using the existing indicators, if necessary. Such features make the T21 the ideal tool to foster the participation and collaboration of International Financial Institutions and other partners in the development plans of the country.

National Development Indicators

The model produces a wide range of aggregated indicators that allow the user to monitor the development process of the country. A very common one is the HDI of the United Nations Development Programme (UNDP), which gives a reasonable measure of the average well-being of people in the country. Another useful indicator of the country's development level is the Gender-Related Development Index (GDI), which measures the differences between the health, education, and income levels for men and women. It also calculates the World Bank's Monitoring Environmental Progress to monitor the environmental progress of the nation and to measure growth sustainability.

Continuous Time-Series Output

To monitor and evaluate the state of the system in any moment of the simulation, the T21 can produce time-series outputs for all variables of the model that the user wants to control. The client can also set the frequency at which each calculation is made and each value is reported, depending on the particular level of accuracy the analysis demands.

Applications

To date, more then 15 customized T21 models have been created and applied, both in industrialized and developing countries. The large size of the model implies a significant effort to customize the model for a specific country, particularly if, as suggested, local experts and policymakers are involved in the process. Generally, however, little work is required to implement the core part of the model. Once the structure is defined, the user only needs to provide the necessary data inputs for the model to work. The additional modules can then be developed separately by different groups of experts, thus reducing the time required for customization.

Final Comment

The T21 is a very useful tool for national policymaking support. Its comprehensiveness guarantees the users' ability to analyze the socioeconomic-environmental system of the country as a whole while testing the effects of different policies both locally and globally—in the short, medium or long term. The user-friendly interface makes it simple for even inexperienced users to explore the model's structure, to define different assumptions and scenarios, and to analyze the simulation's results. The Vensim software, upon which T21 is built, offers many interesting features for analyzing the structure and the behavior of the model, for identifying the behavioral determinants of any variable, and for finding the leverage points in the system.

The modular architecture of the model, which consists of a standard core to which many additional modules can be linked, limits the time and effort necessary to implement the model without reducing the possibilities of accurately representing the specific aspects of the socioeconomic-environmental system of each country. Moreover, this characteristic structure of T21 allows distributed modeling, making it possible for groups of experts from different fields to work separately on the customization of each module, thereby helping to build confidence in the model's results.

Finally, the transparency of the T21, its simple modeling language, and the well-structured outputs foster participation and consensus building among local and international stakeholders by supplying a common framework and a solid basis for discussion.

These and many other features of the Threshold 21 make it probably the most powerful and user-friendly application for country policy analysis available. It is certainly the model that has the most to contribute to the CADO methodology.

RED

The Road Economic Decision (RED) model was recently developed by the World Bank as a tool to evaluate road improvement and maintenance projects for low-volume roads. The RED follows the development of the HDM-3 and HDM-4 (with which it shares some modules) but focuses specifically on rural roads, which are very prevalent in developing countries. The consumer surplus approach is used to evaluate and compare different investment possibilities by measuring the benefits to road users and to consumers of reduced transport costs. The model consists of a series of interacting Excel workbooks. The main module collects the information generated in the other modules to perform the economic evalution of the road. The main modules and their links are reported in Figure 5.

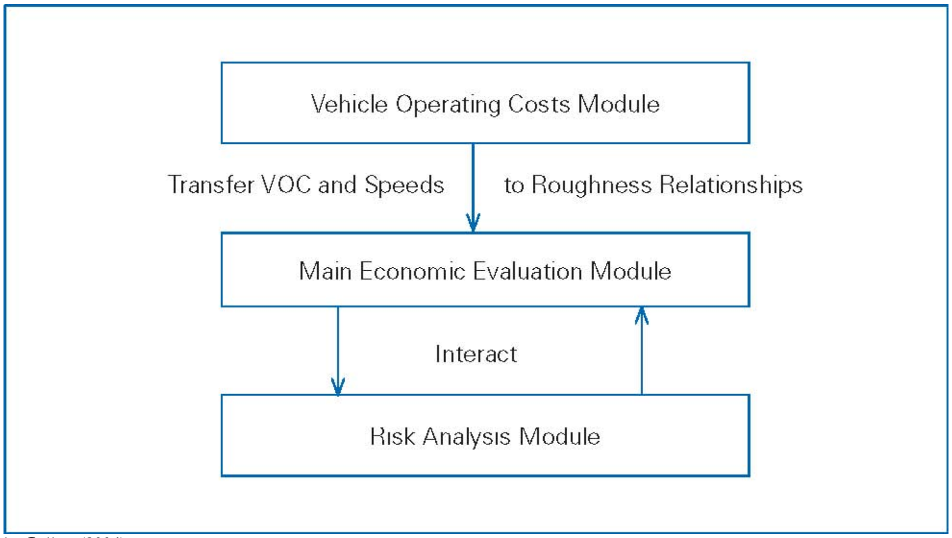
Transparency

The Microsoft Excel software used to define the RED structure of equations allows the user to inspect them directly and, if necessary, to modify them. In reality, the many references in the formulas to variables in other sheets or workbooks make it difficult to understand the sources and uses of the different elements of the structure. The model's guide is only of partial use in this sense. The terminology used in the model is very clear, however, and no specific background is required to interpret and understand the results of the analysis.

Comprehensiveness

The model considers only the economic aspects of a road improvement or maintenance project. The social consequences of the potential policies are not considered at all, and the environmental ones are just mentioned (see the Environmental Analysis

Figure 5: RED Structure Overview



SOURCE: Archondo-Callao (2004).

paragraph). This shortcoming strongly reduces the model's ability to represent a real system and clearly introduces the risk of underestimating the social and environmental effects of a project.

Policymaking Guidance

As a result of the model's low level of comprehensiveness, its usefulness as a policymaking tool is limited. By failing to consider the environmental and social system in which a potential project would be developed, the RED implies a possibility for unexpected effects of the intervention and possibly for policy resistance, particularly in the long run. Moreover, users cannot make cross-sector investment comparisons because the model focuses only on road improvements or maintenance. Therefore, very few relevant insights can be gained from the model, particularly for medium and long term analysis.

Strategy Comparison

The model allows an accurate economic comparison of different possible investments in road maintenance and improvement. With the RED, in fact, users can include three alternative scenarios in the same analysis and can compare them directly with each other and with the hypothetical no-intervention or no-action case. This feature is very useful and allows users to draw conclusions on the economic validity of different investment possibilities and on the feasibility of their implementation, given the resources available. Unfortunately, the narrow focus of the model on evaluating rural road investments does not permit any cross-sector strategy comparison. It is not possible, for instance, to compare the eventual outcomes of investing the same amount of money in road maintenance or in the improvement of the public health infrastructure.

Long-Term Perspective

The RED is mainly oriented toward short-term analysis. The evaluation period can be set to between 2 and 20 years, but given the structure of the model, it is not advisable to extend the projections for more then 10 years in the future. The narrow bounds of the model, coupled with its lack of feedback relationships, strongly reduce the relevance of the outputs produced by the RED on the medium- to long-time horizon.

User-Friendliness

The friendly Excel environment in which the RED is built makes it easy for users to understand the structure of each spreadsheet, where data are well organized and properly labeled. It is more difficult, however, to understand the relationships between the different spreadsheets and to manage the many workbooks that constitute the model. The software gives no clear indications about how the different modules are related to each other, and the user must carefully read the documentation to avoid getting lost in the amount of data displayed. Fortunately, the main module synthesizes and presents the final results of the analysis in a few spreadsheets, so the user does not need to be able to fully manage each workbook, but can instead concentrate on the few data of interest. Regarding the layout, the model uses colors to distinguish between input and output cells, but it has no graphical tools to represent the links between different variables, making it particularly difficult for users to identify the sources of each equation. In summary, although the spreadsheet environment will be familiar to users who are experienced with Excel, they may have problems understanding the way the model works because the relationships underlying the RED are not made explicit in the software.

Environmental Analysis

Model users have the possibility to include as additional costs the expected environmental effects of their investment. Those costs are not calculated by the model but must be set as an exogenous variable by the user, who is assumed to be able to quantify in economic terms the damage that the intervention will cause to the environment. The model then considers this cost in its economic evaluation of the suitability of the investment.

Poverty Analysis

The RED is not suitable for poverty analysis. The model can calculate the economic benefits for road users and for consumers of the reduced transportation costs that were derived from implementing a specific project, but it cannot give any insight into how such benefits will be distributed among the different income classes.

Partnership Building

The outputs produced by the model are mainly economic indicators such as the net present value and the internal rate of return, and a synthetic costs-benefits table for each of the possibilities analyzed. Those structured outputs meet international standard, and they can foster the participation of development partners in the project by presenting the results in a commonly understandable form.

National Development Indicators

Because the purpose of the RED is to analyze local road maintenance and development projects, the model does not incorporate any indicator of the general development process of the whole country. In reality, it cannot even calculate the effects of an investment in terms of socioeconomic development in the region where the road would be built.

Continuous Time-Series Output

As output, the model offers discrete time series for the main variables. Those values are calculated and reported only once for every year of the projection. The frequency of calculations and reports cannot be easily changed by the user. This does not support the careful monitoring and evaluating of the development of the system's key variables.

Applications

The RED is extremely easy to implement, and no specific customization of the model's structure is needed to analyze any kind of road development projects. The data needed as input to the model are limited and are generally easily available. The costs and the time required for applying the software to a real case are therefore contained.

Final Comment

The RED is a valuable tool for the short-term evaluation of investments to improve and maintain low-volume roads. The RED is simple to implement, it requires a limited amount of input, and its use is quite easy for people who are experienced with Microsoft Excel. The outputs are presented clearly and with sensitivity, and the switching values and stochastic risk analyses are integrated to address the high level of data uncertainty that is typical of the economic study of low-volume roads. The RED can be of great support for local agencies that are planning to develop rural roads.

Despite its usefulness for evaluating road projects, the focus of the model is extremely narrow; it does not consider the effects of the project on the regional environmental and social systems. This limitation, together with the general lack of feedback relationships built into the model, thereby reduce its ability to produce relevant insights for the long term. What is more important, the model does not allow the user to consider any policy other than road improvement and maintenance. Therefore, its potential contribution to CADO is extremely limited.

REMI Policy Insight

REMI Policy Insight, the newest version of REMI's software, is a dynamic simulation model created to forecast the economic development of a region or a country under different hypothetical scenarios. REMI can be considered a structural model representing the causal relationships observed in the real system. It is based on two main assumptions: (1) that households maximize utility and (2) that producers maximize profits. The model is articulated in five interacting blocks (Figure 6), which correspond to the main components driving the demand and the supply side of the economy. Those blocks interact to produce long-term predictions of a region's development.

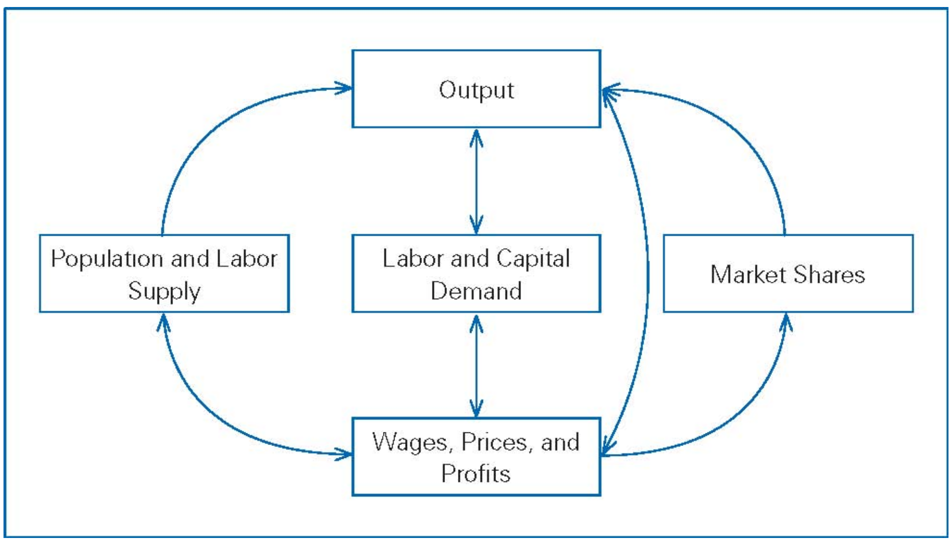
Transparency

REMI is not a very transparent model. Although some information is given about the main structure of the model and about the way its five main blocks interact, it gives no explanations or insights about the relationships that link the different variables. Users cannot explore and modify the model's equations and can receive only a vague idea of what elements influence a variable. This lack of transparency limits the possibilities of the civil society's involvement in the analytical process, and in the long run reduces the users' confidence in the model and in the results that are generated.

Comprehensiveness

The model focuses mainly on analyzing the economic aspects of the development of a country or region. Although an extremely high degree of detail is used to represent the activities of producing goods and services, only a few social variables are included in REMI such as population and employment, which are certainly not enough to

Figure 6: REMI Structure Overview



SOURCE:* REMI *I (2000).

support a real analysis of the development process of a society within a region. The model makes few attempts to represent the environment and its dynamics. However, the influence that the environment can have on human activities—and vice versa—is extremely relevant. REMI, therefore, presents a low degree of comprehensiveness and cannot support an integrated socioeconomic-environmental analysis of a country or region.

Policymaking Guidance

The model's low degree of comprehensiveness implies its limited capability to produce relevant insights to guide policymaking. It can test and compare different policies in the economic sector but it does not support real cross-sector policy analysis. Moreover, the model does not calculate the effects of actions taken on the development of society or the environment. Consequently, users will have to compare the suitability of policies only on the basis of their direct effect on a country's economic development. This approach can easily lead to policy resistance and to the implementation of less than optimal development plans.

Strategy Comparison

The model user can play with many policy variables to test the effects of different development strategies on the future of the region. The results of a simulation can then be compared with the model's projections in the base case of no intervention, with the "Control Forecasts," or with the results from other simulations covering different policies. The user can then perform an analysis of the suitability of each policy. A high degree of freedom is given to the user to set the desired values for the policy variables and the model does not address the issue of the a priori feasibility of implementing a specific action.

Long-Term Perspective

The model can support both short-term and long-term analyses, thus allowing the user to decide the time horizon of the simulation depending on the specific perspective of the study. In reality, as already mentioned, the low degree of comprehensiveness that characterizes REMI implies that its long-term forecasts can be easily distorted because major environmental dynamics are not considered in the model.

User-Friendliness

REMI is supplied with a simple Windows point-and-click interface, which allows all kinds of users to easily orient themselves in the software. The interface has two key windows: the main window and the tab sequence. The main window supports a common Windows menu and a toolbar from which users can choose the kind of simulation they want to run, plus relative options, and can inspect the data underlying the model. The tab sequence is articulated in five subwindows that can be seen as a series of steps necessary to create a new simulation. The user is guided through the steps one by one, thereby reducing the possibility of getting lost in the huge amount of information that the model generates. As a final step of the process, the user can see the results of the simulation displayed as timetables or customizable graphs. To support policy analysis, the results can then be saved and easily compared with the outputs from other simulation runs. Although this procedure can seem quite rigid, it is necessary to help orient the user among the many options and possibilities offered by REMI. The result is a friendly environment where—thanks also to the intuitive boxes and the simplified command buttons in each window—the user will need little time to understand how to use the whole potential of the software. In addition, the interface includes a sophisticated help function, which not only supports alphabetical research by topic and online help but also implements context-sensitive help, all of which are particularly useful in a highly complex model such as REMI.

Environmental Analysis

Although in some specific applications the model has been customized to take into account some environmental effects of a particular policy, REMI was not built to represent the environmental system of a region. The software does not produce a complete set of indicators to monitor the region's environmental conditions. It is not possible, therefore, to use the model to evaluate the full environmental effect of a specific policy. The suitability of a policy can only be assessed on the basis of its estimated economic effect on the region.

Poverty Analysis

REMI dedicates a specific module to the analysis of the economic effect of policies on different income groups. After a simulation run is completed, the Income Distribution option will allow the user to study how income develops for the different classes projected by the model. REMI also reports the percentage of changes in income distribution with respect to the base scenario, and the user can easily compare such results with those from other simulation runs and can choose the policy that is more likely to benefit the poor.

Partnership Building

The model produces many indicators. Although they are not organized in the standard tables required by the different IFIs, the user can easily create custom reports with the desired indicators and information.

National Development Indicators

For each country's simulation run, REMI displays an exhaustive series of development indicators. Because of the nature of the model, these are mainly economic indicators. Very little information about the social development of a country is available, and any changes in environmental conditions are not reported.

Continuous Time-Series Output

The model calculates and reports variables' values on an annual basis. The resulting discrete time series can be considered to be satisfactory when monitoring the system's behavior in the long run, but not for a short-term analysis. If the user wants to focus the study on national economic development in the next two to three years, then monthly or at least quarterly reports would be extremely useful to capture short-term economic cycles and seasonal trends. Moreover, calculating the variables' values once per year implies an assumption that throughout an entire year there will be no differences in the determinants of the rates of change among variables. Such an assumption is unsatisfactory if the time horizon of the analysis is two or three years.

Applications

REMI is currently used by hundreds of governmental agencies, universities, and others. The supplied model is already adapted and has all necessary data for a specific region or country, so the effort required by the user to customize the model is extremely limited. This preprogramming dramatically cuts the time required to get the model up and running and, therefore, reduces the cost of the application down to the simple cost of the software.

Final Comment

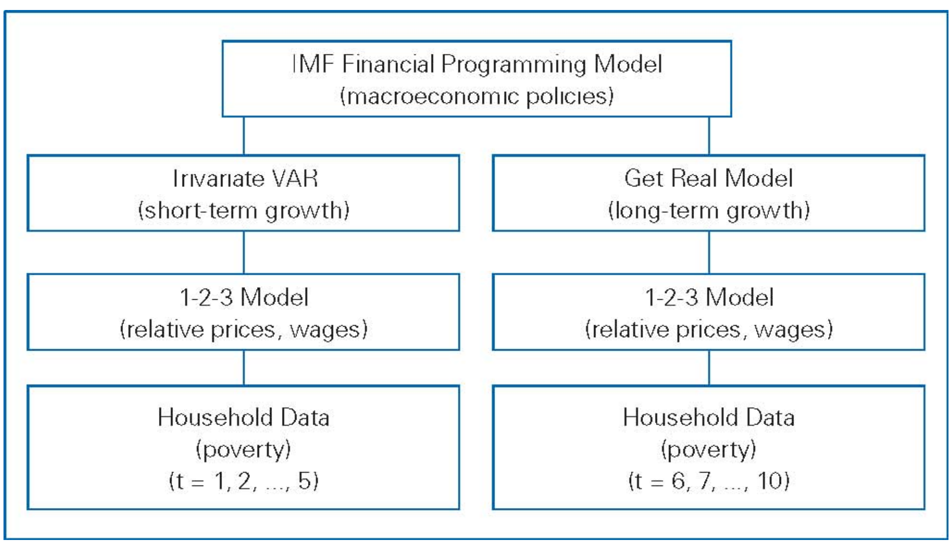
With its high degree of detail, REMI represents the economic system of a country or region and its main demographic characteristics. It uses a wide range of inputs to produce long-term forecasts for the major variables and offers an exhaustive set of indicators to monitor and evaluate the economic conditions of the target area. The software is extremely easy to use. Thanks to a simple, step-by-step sequence, inexperienced users can quickly also quickly run a simulation to test one or multiple policies. The data are reported clearly and effectively, and the comparison between the results of different simulation runs is straightforward. In brief, this model provides as an important example of user-friendliness.

On the flip side, REMI has some important limitations. First, the model is not very transparent. This opaqueness can seriously limit the user's confidence in the simulation's results. Second, the user is not at all involved in the process of customizing the model. Although this preprogramming can save time and money, there is a serious risk that the user will ultimately run the software as a "black box" tool, without really understanding all of its assumptions and resulting in doubts about the validity of the outputs produced. Third, REMI's structure does not support a complete analysis of the environmental system in the target area. This incompleteness naturally limits the possibilities for policy analysis and reduces the trustworthiness of the long-term forecasts that the model generates. For all the above reasons, REMI's results are of limited usefulness to support CADO and for users who are interested in studying not only the short-term effects of an investment on the local economy, but also its effect on the socioeconomic-environmental system of a country as a whole.

1-2-3 (PRSP Framework)

The 1-2-3 model has been developed at the Public Economics Division, Policy Research Department, of the World Bank as a tool to support the analysis of the efficiency and equity of different fiscal policies. The 1-2-3 model can be considered a neoclassic, static, general-equilibrium model. It derives its name from the way it divides the economy of one country in two sectors—exports and domestic goods—and considers only three commodities. It uses a set of given national accounts to generate wages, sector-specific profits, and relative prices. The model is implemented using Microsoft Excel, a common spreadsheet software. It is very compact and requires only a limited amount of data to run. The data are easily available on the World Bank's database.

Figure 7: Overall Structure of the Macroframework for PRSPs



SOURCE: Devarajan et al. (2000).

To fully understand the usefulness of the 1-2-3 model to test developmental strategies for poverty reduction, one should consider it as a part of the "Macroeconomic Framework for Poverty Reduction Strategy Papers," which is presented by the same authors as the 1-2-3 model. In the PRSP Framework, many existing models are linked using a modular approach to create a structure that can support analysis of the effects of different macroeconomic policies on the economic conditions of different income classes. A brief description of the PRSP Framework (Figure 7) is given in the following paragraph. We will refer to this framework as we assess the importance of some characteristics of the 1-2-3 model with respect to the whole structure.

The International Monetary Fund's Financial Programming Model (FPM, upper part of Figure 7) is a static accounting framework developed to evaluate the short-term macroeconomic impact of various policies. The information in the FPM is read by the 1-2-3 model—which calculates the relative prices and wages—and by the Trivariate VAR or the Get Real model—which calculates respectively, the short- and long-term economic growth that derives from the implemented policies. Finally, the Household Data module allows the client to evaluate the effects of the different macroeconomic policies on household welfare.

Transparency

The 1-2-3 model is only partially transparent. In theory, the Excel software should allow the user to examine and, if required, modify all the model's equations. In reality, because of the terminology used, this process is quite difficult to do for those who have little macroeconomic background. Even less transparent is the Visual Basic part of the model, which makes it very complicated for common users to understand how the software really works.

Comprehensiveness

The model is not comprehensive; that is, it is not able to incorporate in the same framework the most important social, economic, and environmental aspects of development planning. In fact, the 1-2-3 is geared toward analyzing the economic effects of different possible macroeconomic policies. Although once it is integrated in the PRSP Framework it can calculate the benefit of a specific intervention on the different income classes, 1-2-3 is not suited for a complete social analysis. Moreover, the environmental aspects of the country's development are not taken into consideration.

Policymaking Guidance

The 1-2-3 model was created mainly to test different policies at a macroeconomic level. It does not have the required degree of detail to support policy analysis at the level of the different economic sectors. It is impossible, therefore, to gain any cross-sector policy insight among the social, economic, and environmental sectors, because of the model's low level of comprehensiveness, or between different economic sectors, because of its low degree of detail.

Strategy Comparison

The analysis and comparison of different development strategies is quite simple because the model allows users to rapidly change assumptions and scenarios and to immediately observe the results of their actions. Moreover, by combining 1-2-3 with the rest of the PRSP Framework, the user can obtain deeper and more interesting insights about the fiscal feasibility of the different policies and can evaluate results in terms of their effectiveness in reducing poverty.

Long-Term Perspective

Users running the whole PRSP Framework are supported for both short- and long-term policy analysis. The Trivariate VAR and the Get Real model can calculate, respectively, the short- and long-term effects that implemented policies have on economic growth. In reality, the way these two models calculate the country's economic growth—primarily on the basis of statistical regression techniques—reduces the reliability of such forecasts.

User-Friendliness

The model's interface is well designed and, together with the many interesting features offered by Microsoft Excel, makes the 1-2-3 a user-friendly tool. The user, in fact, will access all the main functions through a simplified panel with just five main command buttons. Even users who have no experience with Excel will find it easy to get around the model. A few seconds are needed to load the basic data of a particular country and to modify the scenario, as well as to save the results for an eventual comparison of the effectiveness of different policies. Moreover, a complete help function is available to dispel any doubts about the different functions of the software. For a full description of 1-2-3, users should refer to the model's documentation, which is available by clicking on the appropriate link.

Environmental Analysis

The 1-2-3 model is not suited to represent the environment of a specified country. Even when integrated with the rest of the PRSP Framework, the model cannot consider the effect of different possible macroeconomic policies that the user wants to test on the environment. Therefore, the policy recommendations derived will be based only on economic criteria.

Poverty Analysis

Thanks to the Household Data module, which uses the data produced by the 1-2-3 model, the user can easily observe how the implementation of different policies will affect household welfare. The module automatically calculates the income distribution associated with a certain macroeconomic policy for the various deciles. It can also be customized to support analyzing poverty across different areas in a country.

Partnership Building

A very important feature of the 1-2-3 model is that it is set up to be linked with the World Bank's RMSM-X. This link allows the 1-2-3 to use the information produced by RMSM-X. The results of those calculations can be fed back into the accounting model to create the standard output tables required by both the World Bank and many IFIs.

National Development Indicators

Once the 1-2-3 model is incorporated in the PRSP Framework, the user will have access to many development indicators for each scenario projected. Naturally, because of its constraints, the model can generate only economic indicators; it does not support the monitoring of the social and environmental development of a country.

Continuous Time-Series Output

The 1-2-3 is a static model, and it does not produce a continuous time-series output. Depending on the model it is linked with (for example RMSM-X or FPM), it can generate discrete time series for each of the scenarios projected and on different time intervals.

Applications

The 1-2-3 does not require any modeling work to be customized to a specific country's situation, and the amount of data necessary to apply the model is modest. Moreover, all the information required to initialize the 1-2-3 is easily available from the World Bank's database. The time required to implement the model is, therefore, limited, as are the related costs.

Final Comment

The PRSP Framework appears to be a tool that is very easy to use when evaluating the effectiveness of different macroeconomic policies. Unfortunately, the model is able to evaluate only the effects of a specific policy on the economic sector of a country and on income distribution. It does not support real social and environmental analysis. Moreover, because of the model's low level of detail, the user is not supported in cross-sector comparisons of investments. The way the two growth models that compose the PRSP Framework calculate the short- and long-term economic development of the country under analysis is also questionable and raises some doubts about the relevance of the insights generated. Probably the most interesting aspect of the 1-2-3 model is that it is simple, which allows the client, without any support, to quickly learn how to implement and run the model in a few hours and for free. The overall PRSP Framework, moreover, offers some additional important advantages. In particular, the framework's simple modular structure allows modelers to develop the modules one by one, without modifying the whole framework.

IMMPA

The Integrated Macroeconomic Model for Policy Analysis (IMMPA) is a dynamic, quantitative, macroeconomic framework recently developed at the World Bank to support analysis of the effects of different possible policies (and external shocks) on poverty and on income distribution in developing countries. In terms of approach, the model is close to financial computable equilibrium models, with some important differences. In particular, the labor market structure, the links between the financial and real side of the economy, and the government's spending options are carefully represented to give the user the ability to test various policies and provide accurate results. The IMMPA simulation program is implemented in Eviews and uses three Microsoft Excel files to store input and output data, as shown in Figure 8.

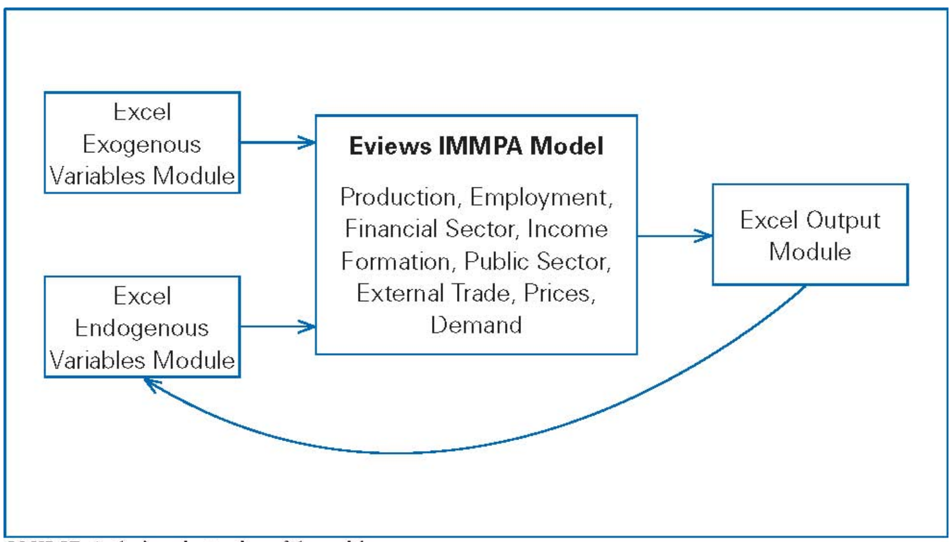
Transparency

The model is well documented, and the main equations constituting its structure are fully explained. However, the IMMPA cannot be considered a completely transparent analytical tool for two reasons. First, users without experience with the Eviews programming codes cannot have access to or modify the model's equations. Second, the terminology used in the IMMPA can be obscure for users who do not have a solid macroeconomics background.

Comprehensiveness

Although the IMMPA is quite well detailed and carefully portrays many of the crucial aspects of the economy of developing countries, it is not comprehensive; that is, it is not able to represent in one framework the economic, social, and environmental structure of a country. In fact, even though the model dedicated to poverty analysis can support

Figure 8: IMMPA Model Overview



SOURCE: Author's understanding of the model.

a partial socioeconomic analysis, no effort has been made to consider the environmental aspects of development planning.

Policymaking Guidance

The detail with which the government expenditures sector is represented in the model allows the user to test—besides many other possible policies—the different possibilities of investment in the different sectors. The user can measure the effect of an increase of governmental spending on infrastructure, for example, and can compare it with the result of an investment of the same amount of money on education or health care. In that sense, the model can support cross-sector policy analysis, although it does not now allow the user to compare investment possibilities across different regions.

Strategy Comparison

The model supports the comparison between many possible development strategies. After each simulation run, the user can save the results and compare them with those generated for other policies to evaluate their relative effectiveness. IMMPA also allows the user to easily analyze the fiscal feasibility and sustainability of a specific policy.

Long-Term Perspective

The time horizon of the simulation can be modified by the user, who can choose to focus the analysis on the short, medium, or long term. However, given the nature of the model, the long-term simulation results produced cannot be very reliable. In fact, IMMPA does not consider the environmental sustainability of the different policies implemented. That aspect of development can substantially modify the behavior of the system in the long run.

User-Friendliness

Because World Bank has not supplied a working copy of the IMMPA program files, only a partial assessment of the model's user-friendliness can be discussed. A generic comment would be that as with other analyzed models that relied on Microsoft Excel, people who are used to Excel should find it easy to navigate the IMMPA spreadsheets. Conversely, Excel does not support any graphical tool that aids in identifying the relationships between variables, which will limit the possibilities for users to understand the real structure of the model and, therefore, its usefulness as a learning tool.

Environmental Analysis

The aim of IMMPA is to assist analysts in evaluating the effectiveness of different macroeconomic policies on poverty reduction. The modelers' focus, therefore, has been on representing the economic sector of a generic developing country. No effort has been made to portray the environmental system and its dynamics in the model, which, as a result, cannot support environmental analysis.

Poverty Analysis

Great importance has been given to developing a module for poverty analysis. IMMPA distinguishes between six categories of households, depending on the level of skills and the location. It calculates for each category a set of indicators to monitor the development of per capita nominal income and consumption distribution. Specifically, for each scenario projected, the model can directly calculate the Gini coefficient, the Theil inequality index, and the Atkinson index. It can also calculate a poverty gap and poverty headcount indexes as it supports the user's analysis of a policy's effectiveness in reducing poverty.

Partnership Building

The model produces many indicators that account for poverty, as well as many other aspects of economic development. Given the high level of flexibility of the software (Microsoft Excel) used to report the simulation results, the user can easily create summary tables that conform to the standard of the World Bank and many IFIs.

National Development Indicators

For each policy tested, the model's user will find it easy to monitor the effect of the policy on the country's economic development, thanks to the many macroeconomic indicators generated. Unfortunately, IMMPA does not produce any indicator of the environmental situation of the country studied.

Continuous Time-Series Output

To support the user in adequately monitoring the dynamics of the system in both the short and the long term, IMMPA can be customized to produce an output for the desired variables over a specific time horizon and at discrete intervals. However, this is a complicated and time consuming operation. Users who are not experienced with the Eviews programming codes will not be able to implement such changes.

Applications

Given the amount of information required to implement the IMMPA model, substantial time and effort are required to find all the essential data and to disaggregate them into the categories defined by IMMPA. However, IMMPA does not require any specific modeling work to be implemented in one country, thus reducing the final cost of the application. Only recently developed, the model has actually been implemented in only a few developing countries.

Final Comment

Among the World Bank's models that are intended to study possible measures for poverty reduction, the IMMPA should certainly be mentioned for its ability to accurately represent a government's different investment possibilities and its ability to produce a complete set of indexes to study the effects of those investments on income and consumption distribution. Moreover, IMMPA is well suited to support cross-sector investment analysis. With a few simple operations, the user can, for example, compare the poverty reduction benefits of increasing governmental expenses in infrastructure with an investment of the same amount of money in education.

Conversely, the model presents at least two important limitations. First, IMMPA is not a comprehensive model; that is, it cannot represent in the same framework the social, environmental, and economic system of a country. This inability not only limits the user to analysis of the economic system, but also reduces the reliability of any results generated in the medium-and long-term simulations because it does not account for major relationships among the economic, social, and environmental sectors. Second, the model is not very transparent, particularly for those who are not experienced with the Eviews programming codes. It is also quite difficult to directly investigate IMMPA's major assumptions. This drawback can seriously reduce the user's confidence in the model, because it will largely end up being used as a "black box" tool.

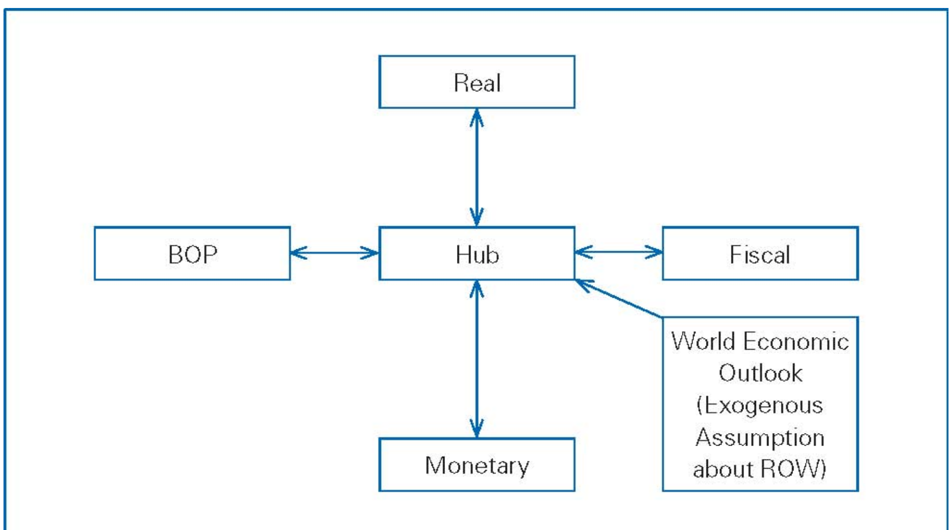
IMF's Financial Planning Framework

The IMF's Financial Planning Framework (FPF) is a spreadsheet model developed to support the analysis of different possible macroeconomic policies, to test their short-term effect on the economy as a whole, and to judge their effectiveness in guiding the country toward internal and external balance. The model can be easily customized to represent any specific country's situation. The model's many policy-testing possibilities include structural, financial, and expenditure policies. The model is organized in four main sectors to represent an integrated system of macroeconomic accounts: the external accounts (balance of payments), real production, fiscal, and monetary sectors. Each sector consists of a structure that includes both behavioral relationships and accounting relationships, which are based on the double-entry approach of the international System of National Accounts. Figure 9 gives a general idea of the overall structure of the model, with the four sectors interacting through a hub model.

Transparency

The FPF is not a very transparent model. Even given the accurate documentation available on the theoretical foundations of each sector composing the model, it is very difficult to understand the way the different sectors are interrelated. The software (Microsoft Excel) used to implement the model does not help because it has no graphical tools or any other intuitive layout to represent the links between variables. However, a sources column on each sheet helps the user understand the relationships between the model's elements by specifying what input is used for each equation. Such support is necessary, considering that the formulas in the cells are not plainly written; that is, they do not give the names of the variables used, but instead use the software's reference system, which can easily lead to confusion.

Figure 9: Overall View of the FPF's Sectors



SOURCE: Author's understanding of the model.

Comprehensiveness

The model's structure has been developed to represent only the economic system of a country. No attempt has been made to represent the social or environmental systems, thus limiting the usefulness of the model for development planning. Assessing the validity of each of the policies tested, in fact, can be done only in terms of the policies' economic suitability and independent of all other effects the policies may have on the population and the environment. This limitation implies a risk that some important forces in the system will be underestimated, which may, in turn, counteract the positive effects of the implemented policies and can eventually lead to policy resistance.

Policymaking Guidance

Given the structure of the FPF, a cross-sector policy analysis is possible between the different sectors of the economy. The way the expenditure options are modeled, however, does not support a high level of detail in the choice between different possibilities of allocating resources. Moreover, no real cross-space policy insights can be generated by the FPF, which always considers the national economy as a whole.

Strategy Comparison

The FPF is well suited for rapidly evaluating the fiscal and institutional feasibility of a financial plan. The comparison of the results of testing different policies is also straightforward, and the user who is proficient with Excel can easily create time graphs that compare the behavior of the main variables for each scenario projected. Modifying the model's assumption, however, is not always simple, and creating new scenarios is a time-consuming operation that is not very practical and can consistently slow down the analysis.

Long-Term Perspective

The FPF has been developed to produce only short-term macroeconomic forecasts, and the time horizon of the analysis is extended over no more than five years into the future. Even if the user could extend this period, the structural characteristics of the model make any medium- and long-term projection of limited reliability.

User-Friendliness

The FPF is an easy-to-use model in which the information is coherently organized. The user will find it easy to navigate the software. Even though no specific command buttons have been created to simplify the navigation or the access to particular functions of the software, the windows features of Excel are intuitive. Thus, moving between the different sheets and functions is simple. For each sector represented, different sheets are used to define different categories of elements, clearly distinguishing between the assumptions, the policy variables, and the main equations of the model.

The model uses color coding to simplify the identification of the major variables; for example, green represents the results of behavioral equations, blue represents the exogenous assumptions, and so on. The main limitations of the FPF in terms of user-friendliness derive from the language used; it can be unclear for those who are inexperienced with macroeconomics or with the particular layout of Microsoft Excel. As noted earlier, Excel has no built-in graphical tools to represent in an intuitive way the relationships underlying any model, making it difficult for the user to understand the overall structure and the mechanics of this model.

Environmental Analysis

The FPF is not able to support environmental analysis. As already pointed out, the FPF's structure does not represent the environmental system of a country, making it impossible for the user to analyze the effects of policies on the ecosystem and, therefore, the policies' sustainability.

Poverty Analysis

Even though the model represents the economic system of a country relatively completely, it is not well suited for poverty analysis. In fact, the population, its dynamics, and its characteristics are not portrayed in the model's structure. Therefore, it is not possible to calculate how the output produced or the benefits derived from a particular policy are shared between the different income classes. Given the flexibility of the software used to implement the model, the user could, in theory, expand the FPF's structure to consider those aspects; however, this would be no simple task and could easily be too much for the skills of the typical user.

Partnership Building

Thanks to Excel's extreme versatility, it is very simple for the user to create custom data tables that summarize the results from implementing different policies. In case the Summary Indicators sheet does not meet the needs of a particular institutional partner, a new table can rapidly be built, thereby combining the FPF's generated information in the desired way.

National Development Indicators

The model produces many economic indicators, and a specific sheet has been created to support the user in monitoring the development of the main variables over time. The sheet displays all the key indicators to monitor the nation's economic development. They are grouped according to their sector of origin, giving the analyst an immediate and global overview. The analyst can then revert to the individual sectors to identify the causes of an observed behavior.

Continuous Time-Series Output

The FPF produces only discrete time series for the main variables. The values for most of the variables are typically calculated on an annual basis. Although this approach can be considered a reasonable approximation of continuity for long-term analyses, its frequency is inappropriate when calculating short-term studies. Because the time horizon of the analysis is only five years, quarterly data series would certainly be more useful for identifying the turning points in a country's economic development and the origins of those points. It would also allow the user to introduce and test seasonal policies.

Applications

Using the model to reflect a specific country situation is not a particularly time-consuming task. The amount of information required by FPF is not very large and consists mainly of statistical data that are easily available from the main IFI's databases. The cost of implementing the FPF is, therefore, low and is one of the main reasons the model is widely diffused and used, particularly in developing countries.

Final Comment

The Financial Planning Framework is a useful model for short-term analysis of macroeconomic policies. It supports policymakers in evaluating alternative financial programs and guiding a country's economy toward external and internal balance. The model is easy to implement and is not particularly time consuming to adapt to a specific country's situation. Moreover, the minimalist interface chosen is practical and flexible because it allows the user to easily modify it, when necessary.

Unfortunately, the FPF does not consider the country's social and environmental systems and it should not, therefore, be used to produce medium- or long-term predictions. The model cannot estimate the effects of the potential policies on the population and the ecosystem in general, which can make the difference between the selection of a sustainable and an unsustainable development plan. The software used to implement the model, although simple to use, does not have graphical tools to clearly present the relationships underlying the model. Moreover, the model's documentation does not offer any specific insights about the way the different sectors interact. This limitation makes it more complicated for the user to correctly understand the model's structure and, therefore, affects its usefulness as a learning tool.

Conclusions

Most of the models analyzed in this work are not able to adequately consider the effects of a potential policy on the socioeconomic-environmental system of a country or region in the long run. Although each model is potentially useful for studying a particular aspect of the development process of a region and although each presents some very interesting features that can contribute CADO, only one can adequately support CADO. Threshold 21 appears to be the most useful methodological tool considered in this analysis in terms of its potential contribution to creating a comprehensive approach to development planning. Although implementing Threshold 21 requires a substantial amount of time and effort, it guarantees a high degree of comprehensiveness and transparency by directly involving the user in defining the network of causal relationships that make up its structure. This extremely powerful tool opens new, wide perspectives in the field of analyzing development programs.

On the basis of this analysis of multiple models, the author concludes that Threshold 21, which already incorporates basic features of the RMSM-X and uses the same software as PDE, should be considered as a fundamental tool to support CADO. In fact, it is the only model reviewed that fully ensures the possibility of cross-space, cross-sector analysis and that supports the comprehensive evaluation of the effects of a potential policy on the social, economic, and environmental systems of a region. Some of the most useful features present in the other models can then be integrated in T21 when a higher degree of detail is needed in each sector. Such modifications can be made thanks to the extreme flexibility of Threshold 21, which can easily incorporate additional structures that reflect different methodological approaches and points of view.

APPENDIX

Summary Table: Ranking the Models by Criterion

Criterion (Min = 0; Max = 10)	PoleStar	RMSM-X	PDE	T21	RED	REMI	1-2-3	IMMPA	FPF
Transparency	8	6	8	9	6	4	5	4	4
Comprehensiveness	5	3	9	10	3	5	4	5	4
Policymaking Guidance	5	4	7	8	3	5	4	6	6
Strategy Comparison	6	6	7	8	5	6	7	6	6
Long-Term Perspective	6	3	9	9	5	8	7	7	3
User-Friendliness	7	6	7	7	5	9	8	5	7
Environmental Analysis	8	2	6	7	4	5	2	2	2
Poverty Analysis	8	5	6	8	3	8	7	8	4
Partnership Building	5	9	6	9	7	7	8	7	7
National Development Indicators	5	4	8	8	1	7	6	6	6
Continuous Time-Series Output	4	5	10	10	4	6	2	4	3
Applications	7	8	6	6	7	8	8	5	8
Total	62%	51%	74%	83%	44%	65%	57%	54%	50%

Note 1: The total is calculated as the sum of the values for each criterion, divided by 120. The maximum possible total is 100%, and the minimum is 0%.

Note 2: The ranking relies on the personal judgments of the author and is based on the usefulness of the different models in terms of their potential contribution to CADO. The reader should use the ranking as a quick reference table and should always refer to the models' documentation for further details.

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Glossary of Abbreviations

CAS	Country Assistance Strategy
CADO	Comparative Assessment of Development Options
CI	Conservation International
FPF	Financial Planning Framework
FPM	Financial Programming Model
GDI	Gender-Related Development Index
GDP	Gross domestic product
HDI	Human Development Index
IMF	International Monetary Fund
IMMPA	Integrated Macroeconomic Model for Policy Analysis
MI	Millennium Institute
PDE	Population-Development Environment
PRSP	Poverty Reduction Strategy Papers
RED	Road Economic Decision
RMSM-X	Revised Minimum Standard Model Extended
SEI	Stockholm Environmental Institute
T21	Threshold 21
UNDP	United Nations Development Programme